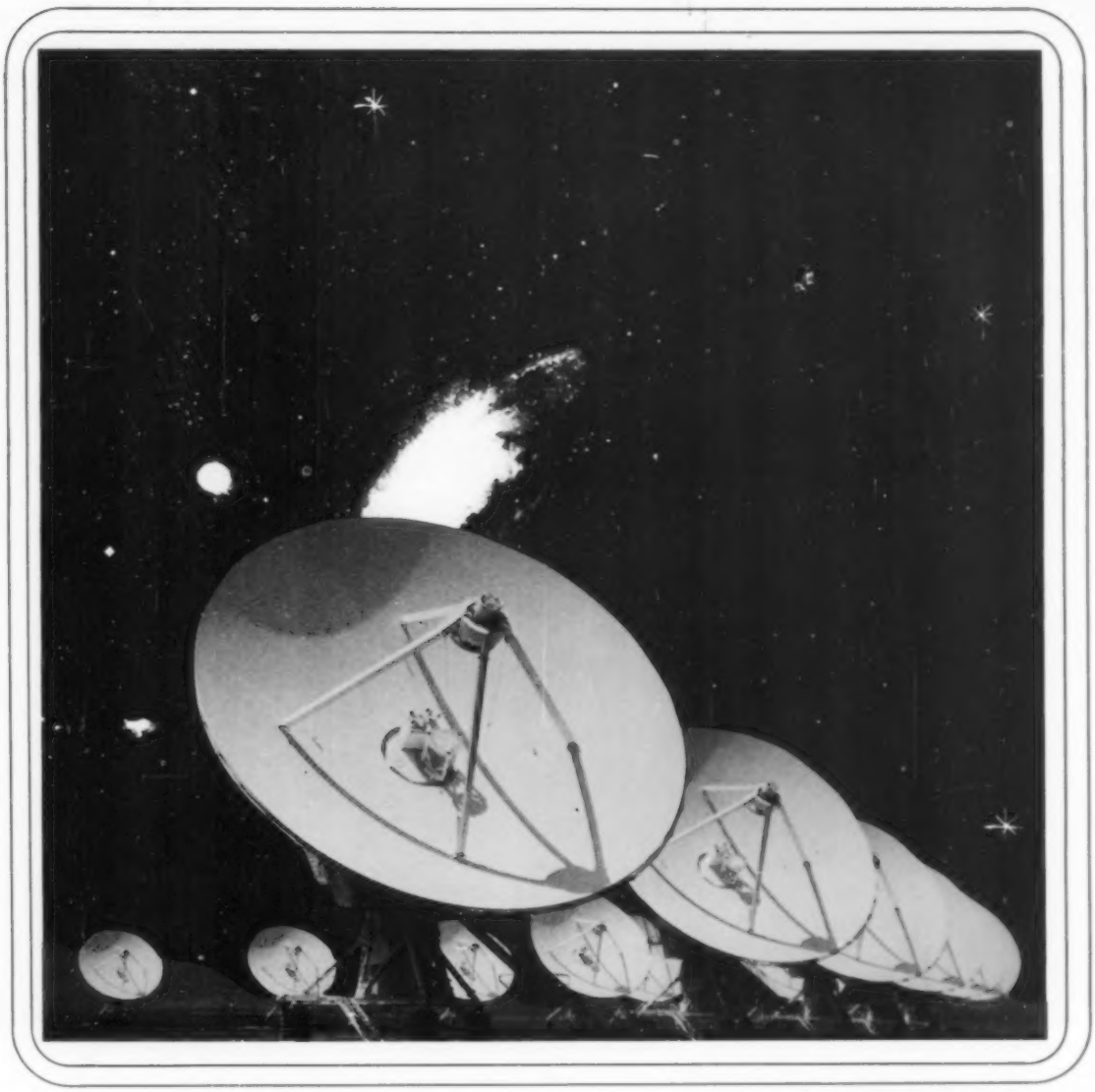
DIMENSIONS NBS

The magazine of the National Bureau of Standards U.S. Department of Commerce

September 1981



LISTENING TO THE STARS. See page 2.

COMMENT

PROJECTIONS AND DIRECTIONS FOR ANALYTICAL CHEMISTRY

Over the past decade, the analytical chemical measurement "industry" in the United States has grown rapidly. Though the boundaries of this industry are somewhat difficult to pin down, a rough estimate of its annual economic dimensions places it near $50 billion. And, as the nationwide investment in analytical data is growing, so too is the quantity of data which, for various reasons, must be retained. Analytical laboratory managers in industry, Government, and universities, therefore, must be concerned with the directions and state of health of the discipline.

One major concern is the reliability of laboratory output. In this connection, we must recognize an important trend: A growing proportion of analytical results are becoming "data of record"—data used to establish trends, to make comparisons, or even to serve as legal evidence.

This movement toward retaining "data of record" will force laboratories to shift from precision-based to accuracy-based measurement. To begin, how would laboratory managers characterize where accuracy stands at the present time? While there is no simple answer, uncertainties are generally higher than desirable and are often intolerable. For example, numerous comparisons among laboratories engaged in trace analysis indicate that errors of 20 percent or more are extremely common and that much larger errors are not unusual. Bearing in mind that investigators are often interested in small differences or trends, a poorly designed or unevaluated analytical approach would be inadequate. The economic and social consequences of analytical error are potentially very great as information sought (and paid for) is hidden in poor measurement.

To help facilitate this shift toward more accurate measurement, managers of analytical laboratories need to compare laboratory results with others to provide key data on, for example, reliability of methods, instruments, quality assurance systems, and standardization. In addition, analytical chemists need to become more involved in the total analytical problem—from design to sampling to sample storage. They need to deal directly with the users of analytical data, and they need to find out what conclusions are to be drawn from the data.

The state of health of analytical research is, in my opinion, quite good. Analytical science, which now has a strong interdisciplinary flavor, continues to produce highly sensitive measurement methods. Lasers, modern data processing, and combined separation-detection methods hold high promise and should give the analytical chemist of the 1980's a formidable arsenal of powerful, but expensive, tools. Some of the driving forces I see which will shape the future of analytical research and hopefully stimulate it are:

- The need to distinguish among chemical forms and valence states of metals (speciation). Species information is needed in connection with a wide variety of problems: toxicity studies, health research, waste management, and others.
- The need to "map" elemental and molecular species on "real" surfaces and in solid materials.
- The need to measure simultaneously many components with minimal pre-separation.

Our analytical research program at the National Bureau of Standards, current and planned, is directed toward developing analytical methods and the means for measurement quality assurance. In general, we are concerned with *quantitative* analysis, and a principal output of this program is Standard Reference Materials (SRM's). Priorities for new SRM's are based on information from users and judgments from within NBS regarding the potential public benefits. These SRM's require extensive homogeneity and stability testing and certification, usually by two or more independent methods.

The research program in the NBS Center for Analytical Chemistry is carried out in three divisions: Inorganic Analytical Research Division, Organic Analytical Research Division, and Gas Particulate Science Division. Recently initiated research areas include laser enhanced ionization, organic electrochemistry, laser ionization in mass spectrometry, and compositional mapping using probe and neutron techniques.

The major problem I have tried to emphasize is the need to improve the reliability of analytical methods. However, in striving for greater accuracy we need to be aware that, although accuracy may be available in some cases, it is often only achievable at costs prohibitively high for routine work. Thus, to keep costs in line, reliable bases are needed to link routine methods to those that are capable of high accuracy. Standards are needed to help provide these bases and we at NBS look to the analytical community for information and data to help us to identify standards needs.

Such standards, integrated into quality assurance systems, offer cost-effective means for assuring that accuracy requirements are matched to the problem at hand.

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The magazine of the
National Bureau of Standards
U.S. Department of Commerce
Volume 65/Number 7

September 1981

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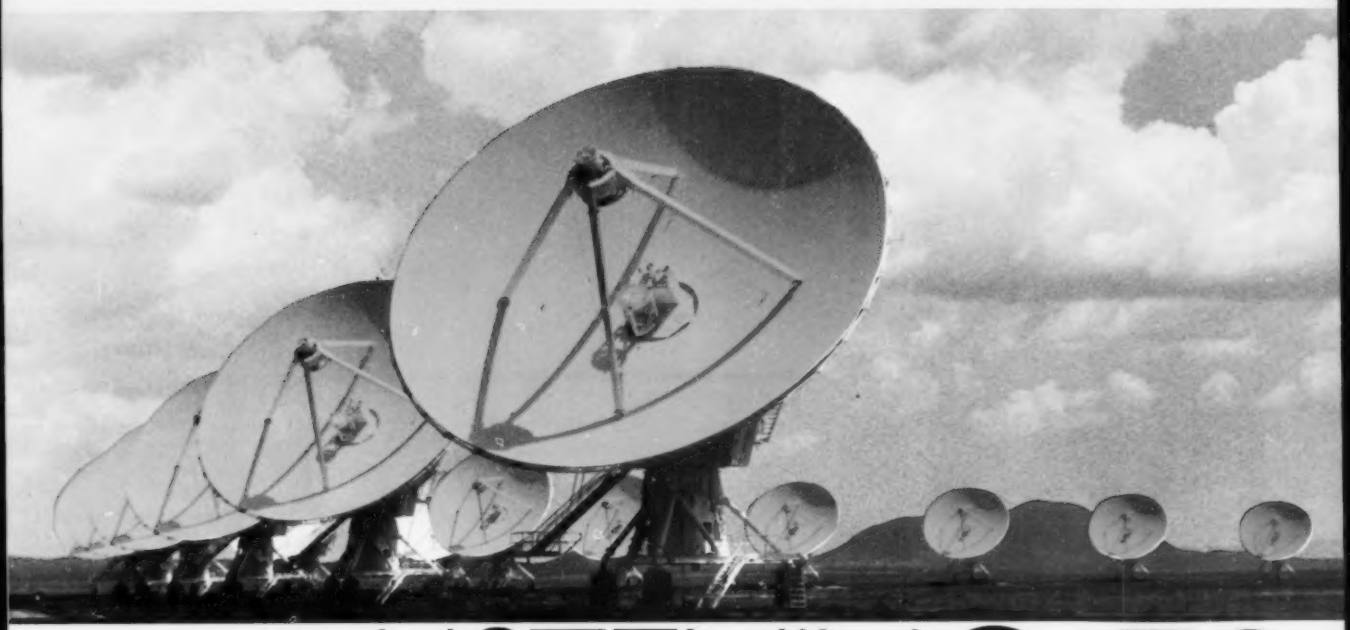


LISTENING TO

by Fred McGehan

FROM the time people first stared with wonder into the starry night sky or were temporarily blinded by the blazing sun, they have been intrigued by the heavens.

Some ancient civilizations believed that stars were small lights hanging from a celestial dome; others believed the lights were holes in the dome through which the fires of hell could be seen. Myth and speculation continued to build through the ancient Egyptian, Greek, and Roman civilizations. Very few facts were available because the principal means for viewing the heavens was a person's unaided sight.

The first telescope was not invented until 1608, relatively recent in terms of human history. And, for the next 300 years astronomers continued to use larger, more powerful optical telescopes to capture and focus light emanating from planets and stars in our galaxy.

Many astronomers now rely on radio waves to study the skies. Only recently, scientists at the National Bureau of Standards (NBS) and the University of Colorado (CU) have discovered a new class of microwave sources among solar-like stars. The discovery sheds some new light on the evolution of these stars—termed single late-type dwarfs—and offers clues as to how the sun evolved from its "youth" to its present "middle age."

A Glimmer of History

Only within the last 50 years or so have astronomers come to realize that light is not the only energy emanating from heavenly bodies. They have discovered that certain of these bodies radiate radio, infrared, ultraviolet, and x-ray energy. And, as with light energy, they have the means on Earth (and sometimes in satellites above it) to capture and focus this energy to learn more about these bodies.

Researchers have been most successful in the field of radio astronomy where the discovery of radio waves from outer space was first made by Karl Jansky. In 1931 and 1932, Jansky, a physicist at Bell Telephone Laboratories, Holmdel, N.J., used an array of antennas to probe the atmosphere for the cause of static that interrupted long-distance telephone communication. After attributing most of the static to thunderstorm activity, Jansky was unable to explain a steady hiss. He later concluded that this noise was coming from the center of the Milky Way galaxy.

The first radio telescope was constructed in 1937 by Grote Reber in the backyard of his home in Wheaton, Ill. (An electrical engineer, Reber worked in the NBS Radio Division from 1947 to 1951.) A

McGehan is a writer and public information specialist in the NBS Boulder Program Information Office.

THE STARS

radio telescope, commonly, is a parabolic dish whose shape reflects radio waves to a focal point called a feed antenna. The radio waves are amplified and fed by cable to an adjacent building where they are further amplified, detected, and integrated. From a backyard beginning, radio telescopes have grown in both size and sensitivity, permitting us new understanding of the composition of stars and planets, the interstellar medium, and the process of evolution that stars and planets undergo.

The VLA

The newest—and most powerful—radio telescope was completed about a year ago by the National Radio Astronomy Observatory* in the high plains of west-central New Mexico, about 80 kilometers west of Socorro. More than just a single, huge antenna, it comprises an array of 27 antennas arranged in a "Y" formation. The array is much more sensitive than previous radio telescopes in discriminating among various incoming radio signals from space and is capable of making radio maps of the sky with a resolving power equivalent to that of the largest optical telescopes. (Resolving power is the ability of a telescope to separate close images like, for example, the two stars of a double star.)

Among the earliest users of this telescope, known as the Very Large Array (VLA), have been Jeffrey L. Linsky, an NBS astrophysicist based at the Joint Institute for Laboratory Astrophysics (JILA) in Boulder, Colo., and Dale E. Gary, a graduate student in the University of Colorado's Department of Astro-geophysics.

Using the VLA, Linsky and Gary have detected two stars that are likely members of a new class of radio sources. The stars are single, cool, dwarf (small by solar standards) stars.

The stars they studied–Chi 1 Orionis and UV Ceti–emit powerful microwave radiation at a 6-centimeter wavelength. Previous observations by other astronomers using the Einstein X-ray Observatory, a satellite-borne instrument, had detected x-ray emissions from these stars, indicating they have hot coronae similar to the sun. A corona is the envelope of hot, highly ionized gas in the outer atmosphere of the sun and certain stars.

Linsky and Gary found that, unlike the x-ray emission due to the high-temperature gas in the corona, the radio emission is due primarily to the spiraling of electrons in strong magnetic fields within the stars' coronae. Prior to their observations, no single, cool, dwarf stars had been detected as radio sources despite many searches, and thus there was

The National Radio Astronomy Observatory is operated by the Association of Universities for Research in Astronomy, under contract with the National Science Foundation.

no definitive evidence that the coronae of these stars possessed strong magnetic fields. Chi 1 Orionis is 33 light years from Earth and UV Ceti is 9 light years away. (Light travels at 300,000 kilometers per second; a light year is the distance that light travels in 1 year's time.)

UV Ceti is too faint to be seen by the naked eye but has been well-studied with optical telescopes; it often brightens in flares 1000 times as energetic as flares on the sun. Chi 1 Orionis is not a flare star but appears to the optical astronomer to be nearly a twin to our sun because it has similar mass, gravity, and temperature. In contrast to the sun, however, Linsky and Gary found that Chi 1 Orionis emits more powerful radio waves and has far larger coronal magnetic fields. The large magnetic fields are consistent with other evidence that suggests that this star is much younger and rotates more rapidly than the sun and is thus capable of generating large magnetic fields by dynamo processes. In fact, observations of Chi 1 Orionis may give astronomers a peek at the sun as it existed some 3 billion years ago.

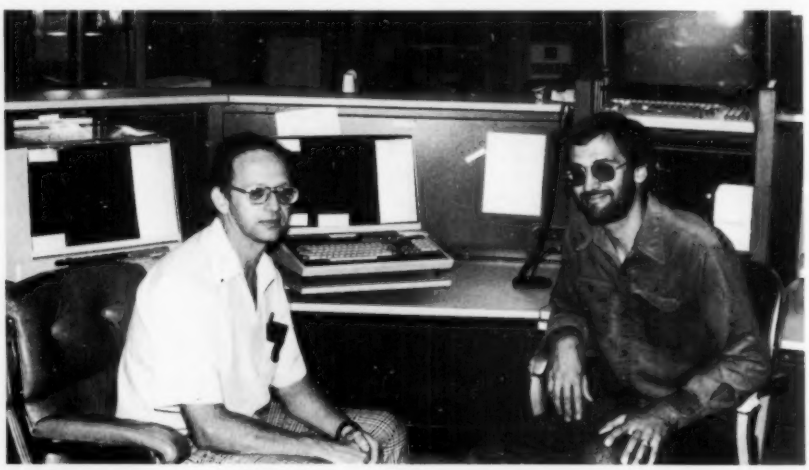
What Lies Ahead?

Radio astronomers, such as Linsky and Gary, are expanding the knowledge of stellar evolution. It is now believed that stars, including our sun, begin when dust and gas form clouds in interstellar space. At a certain density point, the cloud collapses in on itself until densities and temperatures in the core are sufficiently high to generate energy by nuclear fusion. The star then remains stable for billions of years until most of its core is converted to helium by nuclear reactions. At this point the star expands because of increased internal pressures and becomes a red giant. When all of its nuclear energy is exhausted, the core will collapse until only a small, hot, dense, central star remains. Gradually cooling, this star eventually becomes a white dwarf and radiates less and less, ultimately changing into an invisible "black" dwarf—a dead, cold star.

A major uncertainty in this theory is the role that strong magnetic fields play. Theoretical arguments show that magnetic fields can slow down the cloud collapse, prevent the loss of matter to interstellar space as a star ages, and hasten the rate at which rapidly rotating stars become slowly rotating "middle-aged" stars like our sun.

The observations of Linsky and Gary provide the first direct evidence that young stars have strong magnetic fields in their coronae. And now they can begin to test the theory of magnetic influence on stellar evolution by comparing the middle-aged sun to its youthful cousin, Chi 1 Orionis.

The observations, of course, are tentative and await the confirmation of additional studies by Linsky and Gary and by other teams of astronomers. But they do illustrate some of the new data and changes in thinking brought about by probing space with the most sensitive set of ears ever devised. And, when one considers that just over 350 years ago the prime instrument for probing the heavens was the unaided eye, we indeed have come a long, long way. □



Jeff Linsky (left), an astrophysicist in the NBS Quantum Physics Division, and Dale Gary, a graduate student in the Department of Astro-Geophysics, University of Colorado, at the VLA site.

NBS INVENTORS ARE HONORED

Eight

Receive I-R 100 Awards

by Steve Webber

EIGHT researchers at the National Bureau of Standards have won four awards in the 1981 selections of the prestigious I-R 100 Awards.

Sponsored annually by *Industrial Research & Development* magazine, the I-R 100's are awarded to the 100 inventions—selected from thousands of entries—judged to be the most significant new technical products of the preceding year. The awards were announced at ceremonies in Chicago on September 24, 1981.

The NBS award winners this year are:

- Howard Layer, whose portable iodine-stabilized laser increases the accuracy of length measurement by a factor of 5,000.
- Kenneth Harvey, who developed an improved shielded thermionic diode which measures laser wavelengths with an accuracy and resolution at least two orders of magnitude better than those which can be obtained in most spectrometers.
- Charles Tilford, Peter Heydemann, Donald Martin, Richard Hyland, and Frederick Long, who jointly developed an automated high-resolution manometer which extends the present range of liquid column manometry by a factor of 100.
- Thomas Proctor, who has developed an improved acoustic emission transducer that can be used to upgrade the measurement capabilities of industrial acoustic emission instruments, and as a flaw detector for in-service quality control of manufactured products such as integrated circuit chips, stressed pressure vessels, piping leaks, and aircraft.

Webber is a writer and public information specialist in the NBS Public Information Division.

Improved Length Measurement

Howard Layer, of the NBS Center for Absolute Physical Quantities, has for the second time won an I-R 100 Award. This year's award is for developing the NBS Portable Laser Length Standard, an iodine stabilized helium-neon laser system.

The device makes possible the measurement of length with an accuracy improvement from 5×10^{-9} to 1×10^{-10}, a factor of 5,000 over commercially available instruments.

This improvement will enable industrial laboratories and State standards laboratories to have direct access to the same high-accuracy technology which presently exists only in national laboratories. According to Layer, "This device can form the basis

Physicist Howard Layer shows his portable iodine-stabilized laser which increases the accuracy of length measurement by a factor of 5000.

for a new era of metrology which will be available to a wide range of industrial, educational, and scientific users at an unprecedented level of accuracy and precision."

The increased accuracy and performance of the NBS laser results from the molecular system that it employs. Spectrally narrower and more stable than other devices now on the market, this system also does not drift over its lifetime.

The NBS instrument separates the laser function from the wavelength reference function by using a separate absorption cell in the optical cavity. Iodine gas, which is sealed in a quartz cell, instead of the spectrally broader neon, is used as the wavelength reference (four MHz compared to 800 MHz).

Since it is sealed off, the iodine gas does not deteriorate during the life of the laser. This, plus the narrowness of the spectral beam, results in the accuracy improvement of 5,000 and a stability increase of 500,000.

This improved, precise, and stable laser suggests a full array of uses both in science and industry. It will improve the measurement of derived units such as the ohm, farad, and ampere—all of which require precision length measurements of such fundamental constants as gravitational acceleration, the gyromagnetic ratio of the proton, and the Avogadro and Rydberg constants. Potentially the most important scientific application for this device lies in the still emerging field of laser chemistry technology.

Industrially, the portable laser will be useful in length metrology. In the future, it should find use in automated production and inspection facilities which are now pushing the limits of measurement technology—for instance, in the production of very large scale integrated circuit masks.

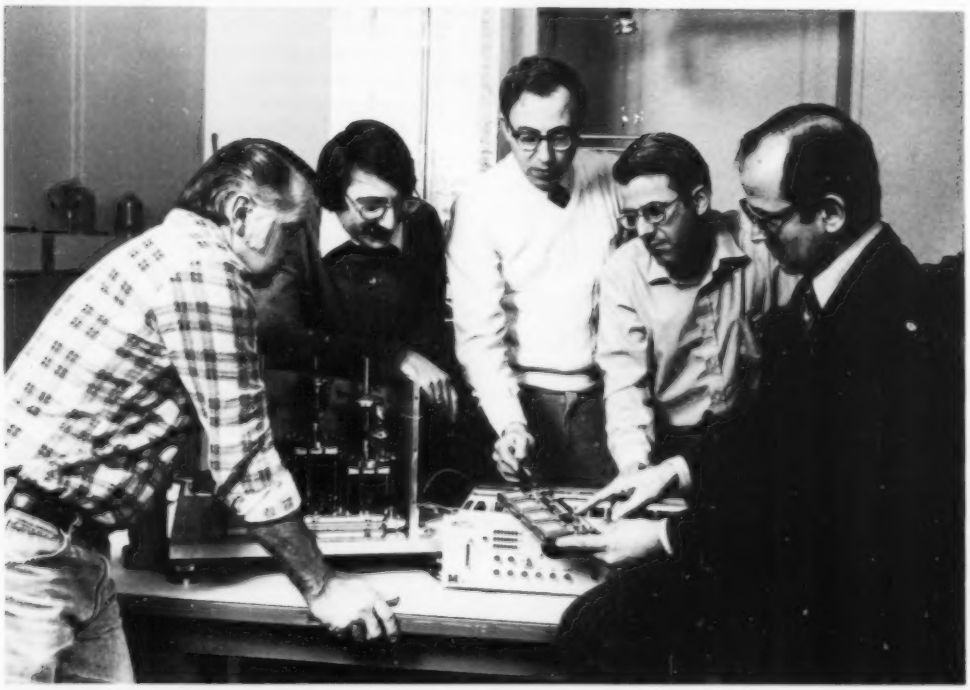
Layer's first award, presented in 1978, was for a novel, smoother drive control system to increase the accuracy of stepping motors commonly used in scientific equipment.

Laser Wavelength Reference

Kenneth Harvey, formerly with the Center for Absolute Physical Quantities, won the I-R Award for his development of a shielded thermionic diode detector used to measure laser wavelengths.

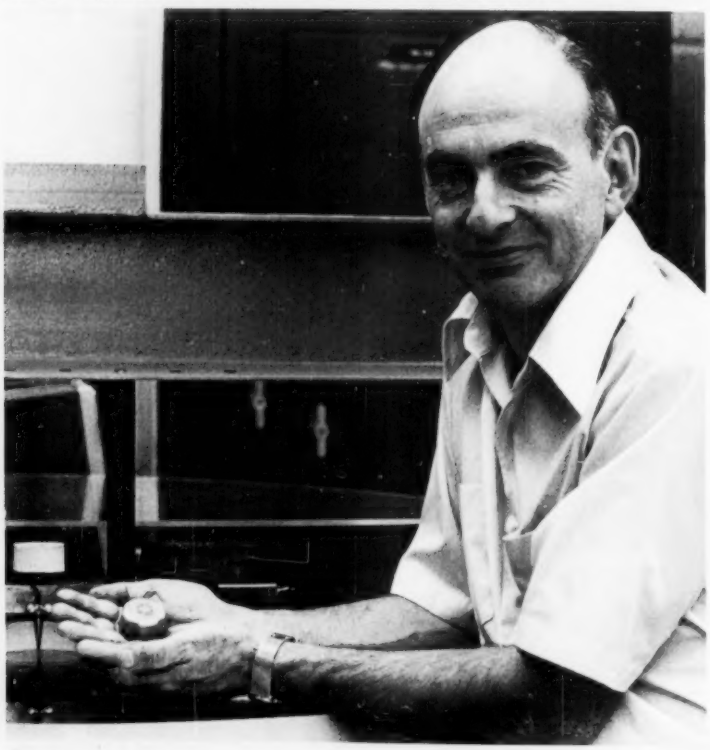
The number of uses for tunable lasers which operate in the visible wavelength range has increased significantly. Most applications, such as iso-

Physicist Kenneth Harvey displays the laser wavelength reference, an improved shielded thermionic diode which measures laser wavelengths with an accuracy and resolution at least two orders of magnitude better than those which can be obtained in most spectrometers.



NBS researchers (left to right) Donald Martin, Fred Long, Charles Tilford, Richard Hyland, and Peter Heydemann check over their jointly developed ultrasonic interferometer manometer. An automated, high resolution manometer, this instrument extends the present range of liquid column manometry by a factor of 100.

Physicist Thomas Proctor holds the improved acoustic emission transducer that can be used to upgrade the measurement capabilities of industrial acoustic emission instruments, and as a flaw detector for in-service quality control of manufactured products such as integrated circuit chips, stressed pressure vessels, and aircraft.



tope separation and molecular spectroscopy, often require a large number of very accurate wavelength references and measurements—to verify or produce correct laser wavelengths.

Harvey's thermionic diode is inexpensive and easy to use for this work in comparison with other wavelength-measuring spectrometers. Reference lines can be provided throughout the visible and ultraviolet portion of the spectrum with an accuracy and line resolution at least two orders of magnitude better than can be obtained with most other spectrometers.

This device can also be used to lock a frequency-stable laser to the lines of a large number of wavelengths. When proper window materials can be used, Harvey predicts that it also can serve to detect radiation in the far infrared portion of the spectrum.

In use, the thermionic diode is placed in an alkali vapor. The vapor becomes excited by the process of one- or two-photon absorption when the radiation is passed through an adjoining shielded compartment.

The wavelength is indicated by the resulting diode current increase which monitors the absorption process. By using different alkalis, hundreds of different wavelengths can be produced, referenced, and measured.

Developed primarily for the Bureau's high resolution research on the fine structure of rubidium, this detector should carry a variety of applications in spectroscopy as well as with frequency standards. Because of the detector's high sensitivity, it should also be useful in atomic and molecular studies.

A New Manometer

Charles Tilford, Peter Heydemann, Donald Martin, Richard Hyland, and Frederick Long, all members of the Bureau's National Measurement Laboratory, developed the ultrasonic interferometer manometer which establishes a new pressure measurement standard in the low pressure range—below 10 kPa (.1 atm).

The device can serve as a primary standard to calibrate high-quality sensors used in a wide variety of industrial and scientific applications, or can be used directly for making measurements where accuracy, speed, and computer compatibility are critical.

Since Evangelista Torricelli's 1644 invention of the barometer, the most accurate way of measuring pressure has been to balance it against the pressure generated by an elevated column of a liquid of known density. This requires the accurate measure-

ment of both the column height and the liquid's temperature.

The heart of the ultrasonic manometer is its improved method of determining the column height by transmitting a pulse of high frequency ultrasound vertically through the liquid column and measuring the *phase* of the signal reflected back from the liquid surface. This process is quickly repeated under microprocessor control for four selected reference frequencies. The column length and pressure are derived from the measured phases using an algebraic algorithm and an on-line mini-computer.

The absence of a need for visual or mechanical access to the liquid columns and the negligible power dissipation of the ultrasonic signals greatly simplifies the control and measurement of the liquid's temperature.

The result is a manometer with a 10- to 100-fold improvement in resolution and accuracy over existing manometers, significantly improved speed and ease of use, and full compatibility with automatic data acquisition equipment.

The principal application is the calibration of high quality pressure gauges used for demanding industrial process control and general scientific instrumentation. The manometer can also be used directly to determine the thermodynamic properties of gases, or to measure very low flow rates of gases. Versions of the manometer with longer columns could be used for applications such as aircraft altimeter calibration.

Acoustic Emission Transducer

The improved acoustic emission transducer developed by Thomas Proctor of the Center for Manufacturing Engineering offers a capability as a standard to transfer amplitude calibrations to other acoustic emission (AE) transducers or equipment, to simplify product flaw evaluation such as leaks in pipes, or to measure flaw growth in products like reactor vessels or aircraft structures. An acoustic emission is a sound wave—or perhaps more properly, a stress wave—that travels through a material as a result of some sudden release of energy in the material. A minute crack in a pressurized gas pipeline suddenly grows a bit longer, for example, and sends a stress wave through the pipe. In principle, if you were listening for it, you could tell from the sound where the stress originated in the pipe and what caused it.

This transducer, with its greater accuracy, precision, and uniformity, produces voltage signals which can be used to faithfully record these sounds. Though not as unique as a set of fingerprints, these signals are distinct enough so that they may be regarded as "acoustic signatures."

The transducer detects flaws by comparing a previously recorded acoustical signature of a defect-free manufactured specimen with the signature of a suspect specimen that has seen heavy use, is actually in use, or is newly manufactured.

As a calibrating instrument, Proctor's device can be used to perform a comparison calibration on a transducer of unknown quality using this new device as a secondary standard. A complete AE measuring system can also be calibrated by using this transducer to measure the magnitude of the surface motion.

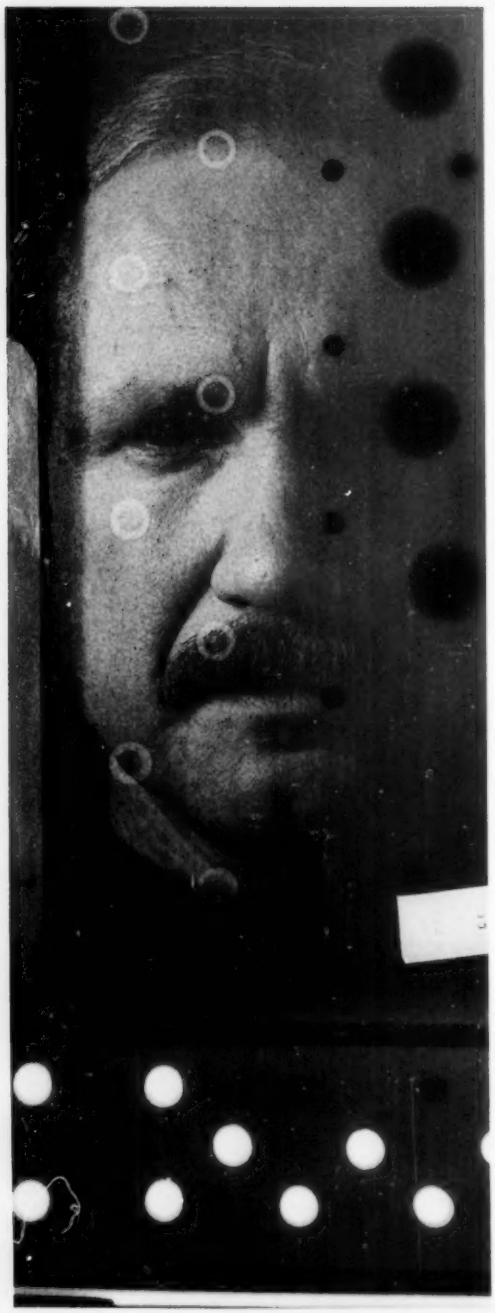
The device faithfully measures the minute surface displacements of an acoustic emission by converting these surface motions to voltage signals. It is an improvement over similar transducers because of its small contact area, its extended element backing, and its simplified construction which eliminates a wear plate and other resonating appendages.

The elimination of the wear plate, the case, and other non-critical elements reduces the interference caused by reflections trapped inside the structure and avoids multiple resonances.

The smaller contact area (1.5 mm diameter) causes this transducer to act as a point receiver, and eliminates "the aperture effect"—the interference common in conventional transducers with large contact areas.

The extended element backing delays sonic reflections off the back of the transducer. This includes both the sonic waves that propagate axially rearward and the waves that propagate at angles up to the radial direction as well. The delay and distribution of this unwanted reflected energy over a much wider timeframe reduces the negative impact of reflections on the primary response.

These three improvements result in a receiving transducer with a very flat response that faithfully reproduces amplitude over a large portion of the frequency spectrum: 50 kHz to 1 MHz, the range of interest for AE signals. □



Charting the World of Radiography

testing the visual acuity of radiographic inspectors

by Jeff Cohn

SIGHT is a sense most of us take for granted. But each of us has a different level of visual acuity, or ability to see fine details. Why? Why do we see what we see? And how do variables such as color, form, and contrast affect what we see? In his search for ways to measure what radiographic inspectors see or don't see, Gary Yonemura, a researcher in the National Bureau of Standards Center for Building Technology, is looking for answers to some of these questions and others regarding the physical attributes of visual perception.

Radiographic inspectors take x-ray films or radiographs of industrial welds and castings and then

Cohn has written articles on a range of science and technology research issues.

analyze them to find imperfections or flaws that could cause vital components to crack and fail.

Catching small imperfections that have been missed in other inspections is not easy; it requires good visual acuity. Cracks or imperfections usually show up on radiographs as thin, blurred lines that often blend in with the background. "It's often not a question of whether you can see the lines clearly," Yonemura says, "but whether you can see them at all."

In recent years, radiographic inspection has become crucial to quality control in U.S. industry. As space age technology has become more exacting and foreign competition more challenging, industry has turned increasingly to radiographic inspection as one way to enhance quality.

First used in the 1920's on military components, radiographic inspection was adopted for a wide range of military equipment during World War II. It is now practiced regularly in the aerospace, nuclear, shipbuilding, toolmaking, and auto industries, among others. Radiographic inspection is especially useful for high-technology components that are too costly to break to examine.

The success of such radiographic inspections depends largely on the visual acuity of the inspector who must accurately, consistently, and reliably recognize a thin, often blurred line and identify it correctly as a crack or a fault, hour after hour and day after day.

Charting What the Eyes Should See

So, how do you know whether the human eye is seeing accurately, consistently, and reliably? Ask that question of an NBS researcher and back comes the standard answer: You test it.

For Yonemura, this involved a two step research project. First, he obtained radiographs of aircraft components and used a microdensitometer, a highly sensitive instrument that detects spectrum lines too faint on a negative to be seen by the human eye, to measure known defects. Yonemura found that distinct defects caused the instrument's needle to swing noticeably while blurred ones, as most are, hardly produced any shift.

From these experiments and others outside NBS came the conclusion that sharpness and contrast are vital to the detectability of objects.

But no standard eye test is available to examine how the sharpness or the contrast of an object with its surroundings affects its visibility. To check for good sight, most standard eye tests use charts

Like a radiographic inspector, Gary Yonemura, a researcher in the Bureau's Center for Building Technology, analyzes an x-ray of rivet holes on an aircraft wing for flaws. From his research on what radiographic inspectors see, Yonemura has drafted a new eye chart to test for visual acuity, the ability to see fine details.

featuring crisp black letters that stand out against a white background. They show what size letters or objects the eye can identify at a certain distance. They include the Jaeger and Snellen charts, the two most widely used eye tests in the United States.

These eye tests may be fine for most sight requirements, but not for those of radiographic inspectors, Yonemura states. "Testing for size alone is not adequate," he says. "Someone who does well on a Jaeger or Snellen chart may not necessarily do a good job as a radiographic inspector." What is needed, he says, is a chart that tests what radiographic inspectors' eyes are expected to see.

Indeed, that is what Yonemura has done in the second step of his research project. Working under a 2-year grant from the Department of Defense's Army Materials and Mechanics Research Center (AMMRC) in Watertown, Mass., he has drafted a new chart to test for visual acuity. The chart emphasizes the ability to see blurred lines that have a low contrast with their background.

Yonemura's draft chart features 5 centimeter by 5 centimeter transparent slides. Each slide has a line with one of four different orientations. The lines may be horizontal, vertical, oblique left, or oblique right. Further, they may vary in width, sharpness around their edges, and contrast with their background. Inspectors would be expected to look at the chart, backlighted by a radiographic viewer, at a distance of about 40 centimeters.

Now that the research is done, Yonemura will propose the draft chart to the Department of Defense this fall as a base from which to develop a new standard test for visual acuity. He plans to meet with ophthalmologists and optometrists to discuss the chart and to begin working out any changes that may be needed. But he declines to predict when radiographic inspectors might use the chart. That depends on how much revision is needed and how long it takes to get agreement on the new chart by

George Hicho (right), a metallurgist in the NBS Center for Materials Science, studies a radiograph of a weld to find and characterize flaws. He compares what he sees on the radiograph with images of flaws obtained by processing the radiograph on an NBS computer graphics facility developed by Clayton Teague (left), leader of the Center for Manufacturing Engineering's Surface Characterization Group.

the visual sciences and radiographic communities.

One possible change, he notes, is to present 4 slides simultaneously, with 3 of the slides blank; that is, with no lines, thus further reducing the chance of successful guessing from 1 in 4 to 1 in 16. But, he adds, the cost and time involved in giving eye tests goes up with their complexity. A test that takes longer might be used less often than a simpler test.

One feature of Yonemura's draft chart is that radiographic inspectors can use it to test themselves. No doctor, nurse, or technician need be present. Thus, inspectors who think they are temporarily not performing as well as required could test and pull themselves off radiographs if necessary.

Once a visual acuity chart is developed, it must be validated before it can be used, Yonemura says. That involves testing it on radiographic inspectors to determine the extent to which varying degrees of sharpness and contrast are important in radiographic inspection. Also to be decided is whether to use a relative or an absolute passing grade. Yonemura recommends the latter, suggesting a score of 70 percent for passing. "We are looking for a minimum ability to see rather than absolute amounts," he says.

An Eye to the Future

After a chart has been developed and validated, Yonemura's and NBS' role in visual acuity will continue. For one thing, the Bureau may propose specifications for the chart so others can reproduce it, or it may create a Standard Reference Material so others can buy the chart from NBS to calibrate their own charts, says Harold Berger, chief of the NBS Office of Nondestructive Evaluation.

For another, other NBS researchers are studying ways to augment radiographic inspectors' eyes with optical scanners and computers. "We would like to automate such functions," Berger says. Here, research goes on under the direction of George Hicho.

Hicho, a metallurgist in the NBS Center for Materials Science, studies radiographs of welds to find and characterize flaws. He compares what his eyes see on the radiograph with images of flaws obtained by processing the radiograph on an NBS computer graphics facility. Hicho then sections the weld and measures the actual length, width, and location within a weld pass of the flaw. His eventual goal is to relate the size and number of defects to the performance of a weld.

The computer graphics facility used by Hicho was developed at NBS by Clayton Teague, leader of the Center for Manufacturing Engineering's Surface Characterization Group. This facility enables a user, such as Hicho, to optimize a picture's exposure and the contrast between the flaw and its background. In addition, the automated picture processing permits Hicho to decide what gray levels on the picture correspond to the flaw and what corresponds to the background. Once these decisions are made based on actual measurements of flaws, the process of inspecting a radiograph for flaws could be automated so that machines could eventually replace human eyes for radiographic inspection.

Yonemura's research will also go on. If his draft chart improves a radiographic inspector's efficiency, that could increase your confidence that a car or airplane or other product is safe and will perform as designed. It could also help U.S. industry erase the quality edge that foreign competitors are seen by some to possess. And even if it just increases inspectors' ability and confidence in doing a good job, that is satisfaction enough for Yonemura. □

NDE TECHNIQUES

Radiographic inspection is but one way to test a product without destroying it. Nondestructive evaluation (NDE) test methods (see DIMENSIONS/NBS, November 1980, pp. 6-9) also include ultrasound, eddy currents, magnetic particles, liquid penetrants, and visual-optical techniques. Used together or separately, NDE methods can help inspectors decide whether a component or structure should be left in service, repaired, or replaced.

Although often costly, nondestructive evaluation can save industry money in the long run by providing information that allows manufacturers to upgrade their processes and thereby cut product failure, Berger says. It also lets manufacturers test every product rather than sample just a few. Once they develop confidence in nondestructive techniques, most manufacturers can reduce testing to a sample, Berger adds. Even then, though, the sample can be larger than that used when testing destroys the product or part.

Where product failure could be disastrous, as in an airplane component that could cause a crash, testing would likely continue for all vital parts. In this sense, nondestructive evaluation replaces the consumer as the primary product tester.

ON LINE WITH INDUSTRY

FRACTURE MECHANICS RESEARCH AIMS AT LOWERING CONSTRUCTION COSTS

by Collier Smith

One of the world's largest universal testing machines is being used at the National Bureau of Standards to pull apart large plates of high-strength steel. The work is part of a program to develop and evaluate better methods of analyzing and predicting the fracture toughness of large welded steel plates such as those used in ship construction.

Similar testing of small, scaled-down specimens has been done for years, but full-sized plates and welds often have residual stresses and flaws which can appreciably reduce the actual strength and resistance to fracture. These flaws and stresses may be absent in small specimens. Small-scale tests can thus produce data which lead to overly optimistic estimates of the strength and toughness of a given material. Since this phenomenon is well recognized, it is compensated for by designing structures with large safety factors. Designers, for example, specify thicker or higher quality plates or more expensive welding processes. Other measures can also be taken, such as requiring more comprehensive inspections of in-process and finished work. These attempts to make the final product safer increase the cost of construction.

On the other hand, full-scale testing of large structural members is also very expensive, and in some cases, simply impossible to do for lack of testing equipment of sufficient size and load capacity. An analytical method is needed which can take data from small-scale tests and produce an accurate assessment of the fracture resistance of large structural members and plates. Part of the development of such a method involves actually doing the large-scale tests that will ultimately be eliminated if a successful method is found.

Smith is a writer and public information specialist in the Boulder Program Information Office.

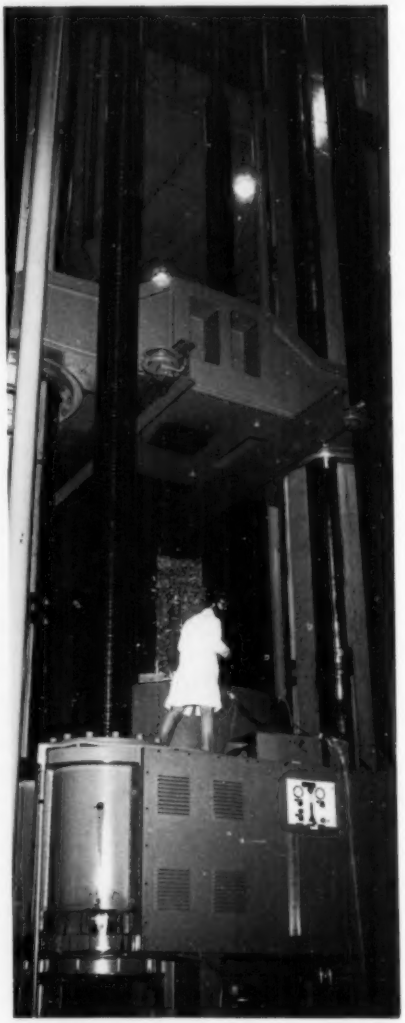
Structural failures can often be traced to improper installation or flaws in the base metal or the welds. Improper installation can be combatted by more thorough inspection and better training and supervision of workers. Fracture mechanics analysis deals with the other element: flaws in the metal and welds. The three broad factors to be considered are the dimensions and characteristics of the flaws (such as cracks, voids, and slag inclusions) compared to the dimensions and shape of the structural member; the basic resistance of the unflawed material to fracture (its fracture toughness); and the amount of force applied at the crack until the member fails.

In principle, fracture mechanics enables any one of these factors to be calculated if the other two are known. In practice, data are seldom complete enough or sufficiently accurate, especially for material resistance and applied force, to allow such a calculation to be done with the desired precision.

In an effort to improve this situation, the Fracture and Deformation Division of NBS is studying all three factors. Physicist Chris Fortunko is developing new ultrasonic techniques for finding and measuring cracks and flaws; metallurgist Harry McHenry is developing new methods and analytic techniques for evaluating the fracture toughness of metals; and physicist David Read is studying techniques for characterizing the crack-driving force.

These studies are being done at the NBS Boulder (Colorado) Laboratories, while the large-scale ship-plate tests are being done at NBS headquarters, Gaithersburg, Md.

The eventual goal of the program is to come up with a method for specifying the maximum allowable size of flaws in base metal and in welds for each kind of material and each class of structural member, including beams, plates, and pipes. Obviously all these different items cannot be tested individually, so general formulas will have to be devised that can be applied to each kind and shape of material. Once these criteria are established and nondestructive tests are developed that can reliably discover and characterize any flaws of that size or smaller, the designer can reduce the safety factor employed, thus reducing the overall costs of construction.



Plates of ship steel up to 60 centimeters (2 feet wide) can be placed in the jaws of the 53,000,000 N (12-million-pound) testing machine and stretched to failure, while data on load and elongation are gathered by computer. This is the largest such machine in the United States.

STANDARDSTATUS

NEW SOURCE FOR TESTING NEUTRON DOSIMETERS

by Michael Baum

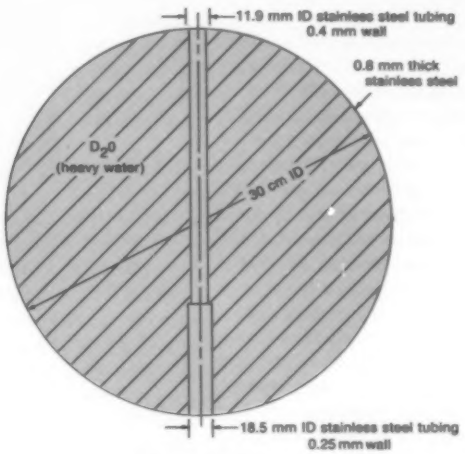
Scientists at the National Bureau of Standards are now using a partially moderated neutron source to test and calibrate neutron personnel dosimeters and protection instruments.

This new source, developed by NBS in collaboration with the U.S. Nuclear Regulatory Commission (NRC), was designed to meet the need for a laboratory calibration source of neutrons with energies roughly equivalent to those found in the vicinity of nuclear power reactors.

The usual calibration for neutron dosimeters uses fission neutrons from californium-252, but recent work has shown that the neutrons to which workers in nuclear power plants are likely to be exposed are at much lower energies because of the moderating influence of materials surrounding the reactor vessel. Since the response of most neutron dosimeters and protection instruments depends strongly on energy, instruments calibrated at high energies may give misleading readings when used to determine the dose equivalent due to much lower energy neutrons.

The new source, a 30-cm-diameter sphere of heavy water surrounding a ^{252}Cf fission neutron source, is now being copied at several U.S. and European laboratories, and is being written into both the latest American National Standard (ANSI) and International Standard (ISO) for testing personnel dosimeters.

Calibrations for neutron personnel dosimeters and other instruments for measuring neutron dose equivalents are now available based on this new source. Calibrations will be made in the range from 50 mrem per hour to 3 rem per hour with an accuracy of ±7 percent. The calibration fee is $250 for the first instrument or group of dosimeters and $150 for each successive instrument or group of dosimeters. For details, contact Robert B. Schwartz, Nuclear Radiation Division, National Bureau of Standards, Washington, DC 20234, or call 301/921-2421.



Heavy Water Sphere

Robert Schwartz (left) and Charles Eisenhauer, both physicists in the NBS Nuclear Radiation Division, position the neutron calibration source. The new source was designed by Schwartz and Eisenhauer, in collaboration with the U.S. Nuclear Regulatory Commission, as a laboratory calibration source of neutrons with energies roughly equivalent to those found in the vicinity of nuclear power reactors.

Baum is a writer and public information specialist in the NBS Public Information Division.

STAFF REPORTS

MOLECULAR PROCESSES AFFECTING DURABILITY OF POLYMERS STUDIED

To develop models that accurately predict the service life of a polymer or improve its mechanical properties and durability, the molecular processes that occur in polymers under stress must be understood. Using highly sensitive Fourier transform infrared spectroscopy (FT-IR), NBS scientists, in collaboration with scientists at the University of Utah, have recently reexamined the ratio of chain scissions to free radicals in long polymer chains. They found the number of new end groups, and therefore the number of chain scissions produced per free radical, to be one to two orders of magnitude lower than previous estimates. This finding is a serious challenge to the assumptions underlying many other studies and is expected to stimulate work based on other mechanisms of polymer fracture.

Bruno M. Fanconi, Polymer Science and Standards Division, A209 Polymers Building, 301/921-3344.

The scission of carbon-carbon bonds in long polymer chains is regarded as the precursor to microvoid formation which initiates the cracks leading to macroscopic failure. The primary bond rupture produces free radicals that may transfer and cause many more chain scissions before recombination to form stable chemical species.

The evidence for multiple chain scissions per initial free radical comes from comparing the electron spin resonance measured number of free radicals generated during mechanical degradation with the number of chain scissions determined from infrared spectroscopic measurements of new end group concentrations. Other estimates of the number of chain scissions are derived from measuring the reduction in the viscosity-averaged molecular weight. The number of chain scissions per free radical determined by viscosity measurements on mechanically damaged polyethylene is several orders of magnitude lower than the ratio evaluated from previous infrared data. The discrepancy between these two determinations affects the direction of other work. For example, the infrared data suggest that the addition of a free radical scavenger or the design of a polymer that minimizes radical transfer mechanisms might improve mechanical durability.

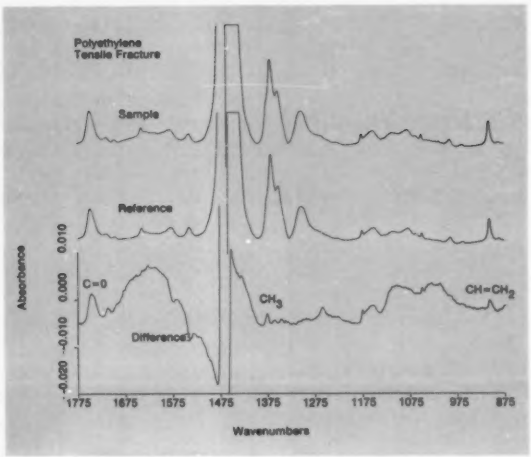


Figure 1—*IR spectral changes in mechanically damaged polyethylene.*

We used sampling techniques that minimized the effects of molecular orientation, changes in sample thickness, and surface texture that plagued earlier infrared measurements. The spectra for polyethylene fractured under tensile loading, the reference (unfractured) polymer, and the difference between these two are shown in Figure 1.

Infrared bands in the difference spectrum can be assigned to new end groups. The bands in the 900-1000 cm^{-1} region arise from vinyl groups, the band near 1375 cm^{-1} is due to the methyl groups, and bands in the 1700-1750 cm^{-1} region are attributed to carbonyl groups. We

Table 1

New End Groups Formed During Fracture of Polyethylene

Group	IR Band (cm^{-1})	Concentrations ($No./cm^3$) This Work	Ref. 1
$RCH=CH_2$	909	$1.3\pm.4\times10^{17}$	3.4×10^{18}
$RCH=CHR$	965		1.9×10^{18}
RCH_3	1370	$7.3\pm.4\times10^{17}$	11.8×10^{18}
RCHO	1735	$1.9\pm.6\times10^{17}$	4.6×10^{18}

Ref. 1. S. N. Zhurkov et al, Sov. Phys. Solid State *13*, 1680 (1973)

Comparisons with ESR No. Chain Scissions Per Radical

This Work	69-125
Ref. 1	1,600

observed increases in the concentrations of terminal vinyl, methyl, and aldehyde groups. The concentrations of the new groups are given in Table 1 along with the ratio to free radicals. Comparisons with previous estimates show that the ratio is one to two orders of magnitude lower and in much better agreement with the viscosity results.

Among the polymeric materials investigated was ultra high molecular weight polyethylene which is widely used for its superior mechanical properties. Due to the extremely low initial concentrations of end groups in this material, it was used to investigate molecular processes associated with the more mild mechanical degradation under conditions of cyclic loading (fatigue). Specimens were fatigued to failure at different stress levels so that the number of cycles to failure varied by several orders of magnitude. Examination of these specimens by FT-IR showed that failure occurred at a critical concentration of chain scission which was independent of stress level and the number of cycles. This result supports the concept of a critical damage level and current studies are aimed at establishing the relationship between the concentration of chain scissions and mechanical durability.

NEOMYCIN B STUDIED

Researchers at the NBS high-field nuclear magnetic resonance facility have demonstrated the usefulness of proton and nitrogen-15 magnetic resonance parameters for the structural, conformational, and quantitative analysis of complex aminoglycoside molecules. They obtained results which, for the first time, define unambiguously conformational forms of the individual sugar units in neomycin B.

Robert E. Botto and Bruce Coxon, Organic Analytical Research Division, A367 Chemistry Building, 301/921-2867.

Although modern-day antibiotics have been heralded as the answer to many of our afflictions, in recent years there has been an alarming increase in the number of reports describing infectious bacterial strains that are resistant to antibiotic treatment.* These bacteria possess a highly developed, enzymatic assembly that either degrades the antibiotic or modifies its structure to an inactive form. The ability to synthesize the inactivating enzyme spreads from one species of bacterium to another by transfer of genetic material in the form of "plasimids" containing segments of DNA that carry coding for biosynthesis of the enzyme.

Despite the number of aminoglycoside antibiotics available today, the phenomenon of bacterial resistance to these naturally occurring substances has fostered an ever-increasing interest in developing new types and analogs that exhibit a much broader spectrum of antibacterial activity, with less toxicity and susceptibility to inactivating enzymes. Extensive research programs are currently in progress, particularly in the pharmaceutical industry, in the areas of partial synthesis and genetic and chemical modification, leading to second- and third-generation antibiotics.

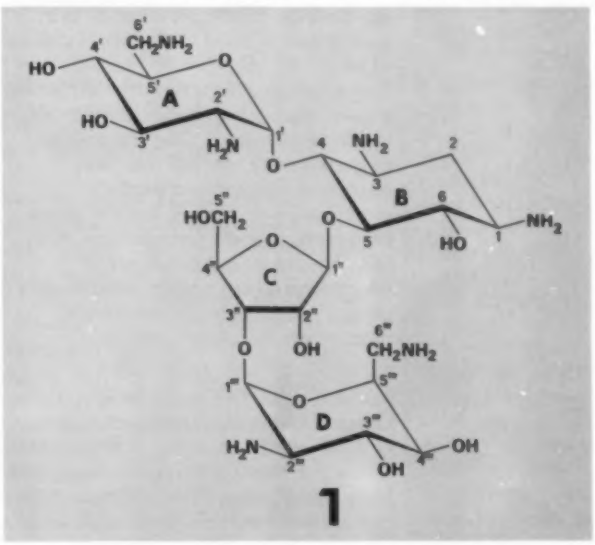
*See editorial in Nature, 292 (1981) 661.

Since classical means of structure elucidation are often tedious, time consuming, and wasteful of materials, convenient methods to study structures and reactivities, and to guide attempts to modify these substances chemically, are therefore in demand.

Nuclear magnetic resonance (NMR) studies that we performed at the NBS high-field NMR facility demonstrate the utility of proton and nitrogen-15 magnetic resonance parameters obtained at high field for the structural, conformational, and quantitative analysis of aminoglycoside substances. The NMR parameters employed include chemical shifts (spectral line positions), coupling constants, spin-lattice relaxation times, nuclear Overhauser effects, and signal intensities.

The initial phase of this research was devoted to characterizing components in the "neomycin complex," i.e., the isomeric neomycins B and C. Quantitation of the neomycin B/C ratio in commercial neomycin preparations was accomplished by digital integration of the proton and nitrogen-15 NMR signals.

Nitrogen-15 spectral line positions of four derivatives of neomycin B (Structure 1) were determined for comparison with those of structurally related pseudo- and



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monosaccharides. The close correspondence of the spectral line positions for nitrogens of a specific structural type in both the antibiotic and model compounds facilitates their assignment and allows a reliable set of substituent effect parameters to be derived from the data. Using these parameters, we developed empirical methods which have enabled us to calculate reasonable line positions for the limited number of aminoglycoside molecules for which published data are available. We were thereby able to establish structure-spectral correlations for this general class of molecules.

Moreover, analysis of the proton and nitrogen-15 NMR spectra has given results which, for the first time, describe conclusively conformational forms of the individual sugar residues in neomycin B.

The pK_a values for all six nitrogen groups in neomycin B were determined simultaneously from a nitrogen-15 NMR—pH titration study, as is illustrated in Figure 1. Once smooth sigmoid curves are constructed through the points for the individual nitrogens, the pK_a values can be readily calculated from the data to ± 0.04 pK_a unit by use of a general curve-fitting procedure. It can be seen from the titration curves that all of the nitrogens in the antibiotic are essentially fully protonated at pH <4.5, and fully unprotonated at pH >10.5. Furthermore, comparison of the values extracted from the curves at pH 6.7 (indicated by the arrow) with those determined for a solution of neomycin sulfate at the same pH serves to characterize the sites and extent of protonation in neomycin B in the commercial preparation.

Nuclear relaxation measurements provide an exciting new method for determination of steric accessibility factors at the nitrogen sites in the antibiotic molecule. These data, in conjunction with a knowledge of the relative base strengths of the nitrogen groups, should serve as an excellent guide for chemical modification of the nitrogen sites in these substances. Aminoglycoside antibiotics are also of interest as potential future clinical Standard Reference Materials.

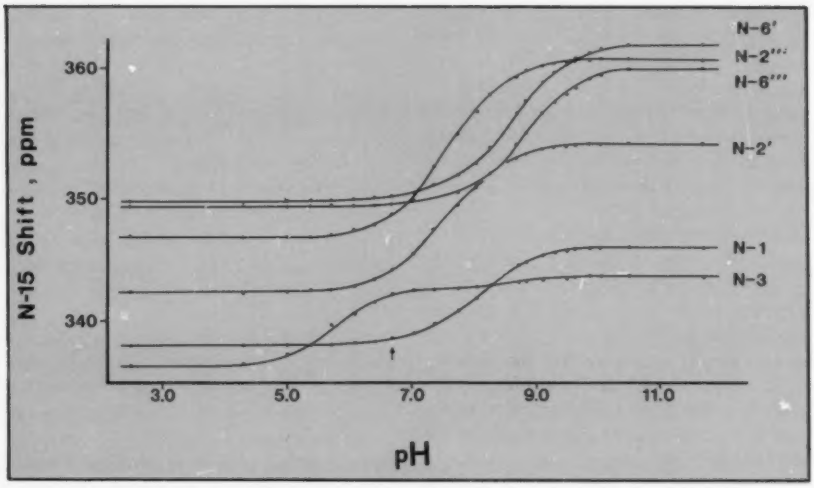

Figure 1—*Nitrogen-15 NMR—pH titration study of neomycin B.*

SERS USED TO STUDY MOLECULAR INTERACTIONS

NBS scientists are using a recently discovered phenomenon to study the interactions between molecular species in solution and metallic electrodes. The technique, surface-enhanced Raman spectroscopy (SERS), produces up to a million-fold increase in the Raman spectra of molecules adsorbed on metals. Consequently, SERS is expected to provide a novel approach to studies of molecule-electrode interactions, the composition of the electrode-solution interface, changes in reactants and products produced by electrolysis, and the causes of the enhancement phenomenon. Also, SERS is expected to provide useful information on the surface characteristics of electrodes chemically modified to produce electrocatalytic sensors.

Kathryn A. Bunding and Richard A. Durst, Organic Analytical Research Division, A113 Chemistry Building, 301/921-2446; Michael I. Bell, Polymer Science and Standards Division, A165 Materials Building, 301/921-3662.

Surface-enhanced Raman spectroscopy (SERS) is a recently discovered phenomenon which gives highly resolved spectral data of some molecular adsorbates. Currently unexplained, it is a phenomenon that produces as much as 10^6 enhancement of the Raman spectra of molecules adsorbed on metals such as silver and gold. Some of the theories that have been proposed involve coupling into surface plasmons via atomic, molecular, or large-scale surface roughness as well as field and image enhancement due to surface roughness.

The research at NBS is directed towards using the SERS technique to investigate *in situ* molecule-electrode interactions. The enhancement of the spectra of surface species makes SERS ideally suited for these studies. Such applications of SERS may prove to be an important tool for studying not only molecule-electrode interactions, such as orientation and bonding, but also double-layer composition, and the products of electrode reactions, and for furthering understanding of the enhancement phenomenon.

The basic system consists of general-purpose Raman equipment: an argon-ion laser, a double-grating monochromator

with a photomultiplier, and photon-counting electronics with microcomputer-controlled data acquisition, storage, and display. Several Raman-electrochemical cells have been designed consisting of working, counter, and reference electrodes; a port for deaerating the solution; and an optical window for the spectroscopic studies. A thin-layer cell has been designed to minimize the interference of solution spectra and to facilitate rapid equilibration of the redox reactions.

This technique has been successfully applied to studies of a number of pyridine derivatives (carboxaldehydes, methylketones, and carbinols) and the effects of adsorbate-substrate interactions have been identified. The 4-substituted carboxaldehydes and methylketones exhibit weaker carbonyl stretching bands when adsorbed on silver than in solution, while no such effect is found for the corresponding 3-substituted compounds. This is consistent with an interaction of the nitrogen lone-pair electrons with the silver, leading to electron withdrawal from 4-substitutents and increased hydration of carbonyl groups at that position. Examination of several N-methylpyridinium salt solutions shows a similar trend, with N-methylation increasing the degree of hydration and reducing the carbonyl band intensity in 4-pyridine carboxaldehyde but not in 3-pyridinecarboxaldehyde. The effect of adsorption is more dramatic, however, since the SER spectrum of 4-pyridinecarboxaldehyde is identical to that of the corresponding carbinol, indicating that the aldehyde is completely hydrated on the electrode. Thus, SERS allows us to identify the surface species and to show that it is quite different from that found in bulk solution. This result could not have been anticipated on the basis of cyclic voltametry since no electrochemical reaction is required to produce the surface species.

Another study which has important implications on the surface metal interface uses N-methylpyridinum ions which show surface enhancement only when iodide is in the solution. No enhancement is observed with only chloride in solution. These studies are important because the N-methylpyridinium ion has no nitrogen lone-pair electrons for bonding and is, in fact, an organic cation. These types of molecules have received little attention in SERS studies.

Many biomolecules undergo very slow heterogeneous electron transfer. This behavior is attributable to adsorption of the biocomponent on the electrode surface and/or isolation of the electroactive center by the protein matrix. This problem can be circumvented by addition of another species to the solution, a mediator-titrant, which transports electrons between the electrode and biocomponent. 4,4'-Bipyridine has been found to mediate electron transfer between cytochrome C and gold electrodes. Some workers have proposed that it mediates only when it is in a particular orientation with respect to the electrode surface. Preliminary results have indicated that this is not true on silver. SERS should be able to provide other valuable information on the interaction not only between the electrode surface and the mediator, but also the mediator and the protein.

It is anticipated that SERS will prove to be extremely useful in studying the surface characteristics of electrodes modified by the attachment of polymers and other electrocatalytic moieties. These polymer-modified electrodes are currently being investigated to determine their properties and analytical potential.

NEW GAMMA-RAY SRM'S HAVE GREATER LIFETIMES

NBS has recently issued new gamma-ray Standard Reference Materials (SRM's) with much greater useful lifetimes. These SRM's, developed by the NBS Radioactivity Group, can be used for several years as opposed to a few months for previous NBS standards developed for the same purpose.

Gamma-ray spectrometry with germanium detectors is widely used for radionuclidic measurements, especially if mixtures of gamma-ray-emitting radionuclides are to be assayed, in environmental monitoring, nuclear medicine, and many other fields.

These two new Standard Reference Materials—SRM 4275 and SRM 4276—have been issued for calibrating and checking the efficiency of spectrometry systems as a function of energy. These SRM's have certified gamma- or x-ray emission at 18 energies from 27 keV to 1.27 MeV. The rates for a master solution were measured on four germanium-spectrometry systems especially calibrated for the purpose. SRM 4275 is in the form of a solid, low-mass "point" source on a low-scatter mount, and SRM 4276 is a stable solution which can be used to prepare sources corresponding to those measured in a purchaser's laboratory. Each gram of the solution contains a mixture of ^{125}Sb, ^{125m}Te, ^{154}Eu, and ^{155}Eu sufficient to give emission rates of about 1000 to 6000 photons per second at each energy.

SRM 4275 and SRM 4276 may be purchased from the Office of Standard Reference Materials, B311 Chemistry Building, National Bureau of Standards, Washington, DC 20234, for $319 each.

TABLE

Counting rates observed for principal gamma- or x-rays for SRM 4275-S at 26 cm from a 80-cm³ closed-end coaxial Ge(Li) detector.

Radionuclide	X—or Gamma-Ray Energy (keV)	Counting Rate $c\ s^{-1}$
^{125}Sb-^{125m}Te	27.4	2.84
^{155}Eu-^{154}Eu	42.8	12.25
^{155}Eu	86.6	14.85
^{154}Eu	105.3	10.51
^{155}Eu	123.1	42.44
^{125}Sb	176.4	5.15
^{154}Eu	248.0	4.38
^{125}Sb	427.9	8.61
^{125}Sb	463.4	2.72
^{125}Sb	600.6	3.52
^{125}Sb	635.9	2.11
^{154}Eu	723.3	3.84
^{154}Eu	873.2	1.93
^{154}Eu	996.4	1.44
^{154}Eu	1004.8	2.47
^{154}Eu	1274.4	3.81

CONFERENCES

For general information on NBS conferences, contact Roger Rensberger, NBS Public Information Division, Washington, DC 20234, 301/921-2721.

ARSENIC SYMPOSIUM

A symposium on arsenic compounds will be held on November 4-6, 1981, at the National Bureau of Standards, Gaithersburg, Md.

Sponsored by NBS and the Chemical Manufacturers Association, the symposium will consist of lectures by experts in the production and use of arsenic and its compounds, in the environmental and biomedical properties of arsenic, and in epidemiology. The symposium will also provide a means whereby representatives of industry and Government agencies may reach an understanding on cost effective regulation of arsenic as a hazardous material.

Arsenic occurs naturally in fossil fuels, ores, and some drinking water supplies. Mineral deposits containing arsenic include: copper, lead, zinc, phosphates, uranium, gold, cobalt, and silver. Smelting, mining, or leaching these deposits produces commercial products used extensively in industrial and agricultural applications. Arsenic may be present as an industrial by-product in air and water emissions and as a solid waste.

The properties of arsenic, as measured in environmental and biological systems, are related to its valence state, its ability to form a variety of chemical complexes, and its interactions with other elements or compounds. Scientifically sound development of air and water standards, regulation of pesticides and solid waste, and health and safety issues must necessarily take these factors into consideration. The symposium will bring the current state of knowledge concerning the properties of arsenic compounds into an open forum for discussion. It will also serve as a guide for future biomedical and environmental research on arsenic.

All those attending this symposium will be sent published proceedings when they become available. The proceedings will include the discussions that follow each lecture.

For further information, call or write: Robert J. Fensterheim, Administrator, Biomedical and Environmental Special Programs, Chemical Manufacturers Association, 2501 M Street, N.W., Washington, DC 20037, or call 202/887-1189.

CONFERENCE CALENDAR

December 8
COMPUTER NETWORKING SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and IEEE; contact: Robert Toense, B226 Technology Building, 301/921-3516.

1982

January 19-21
SYMPOSIUM ON SILICON PROCESSING, San Jose, CA; sponsored by NBS and ASTM; contact: Elaine Cohen, A308 Technology Building, NBS, 301/921-3786.

March 3
FIPS SOFTWARE DOCUMENTATION WORKSHOP, NBS, Gaithersburg, MD; sponsored by NBS; contact: Albrecht Neumann, A265 Technology Building, NBS, 301/921-3485.

March 14-18
SIXTH SYMPOSIUM ON TEMPERATURE —ITS MEASUREMENT AND CONTROL IN SCIENCE AND INDUSTRY, Washington Hilton Hotel, Washington, DC; sponsored by NBS, Instrument Society of America, and American Institute of Physics; contact: James Schooley, B130 Physics Building, NBS, 301/921-3315.

March 15-17
HUMAN FACTORS IN COMPUTER SYSTEMS, NBS, Gaithersburg, MD; sponsored by NBS and ACM; contact: Wilma Osborne, A265 Technology Building, NBS, 301/921-3485.

March 22-26
FOURTH ASTM-EURATOM SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and ASTM; contact: Charles Eisenhauer, C310 Radiation Physics Building, NBS, 301/921-2685.

March 29-April 2
AMERICAN CRYSTALLOGRAPHIC ASSOCIATION, NBS, Gaithersburg, MD; sponsored by NBS and Crystallographic Association; contact: Camden Hubbard, A221 Materials Building, NBS, 301/921-2921.

April 20-22
MECHANICAL FAILURES PREVENTION GROUP, NBS, Gaithersburg, MD; sponsored by NBS and MFPG; contact: T. Robert Shives, B120 Materials Building, NBS, 301/921-2934.

June 1-4
NEUTRON TRANSMUTATION DOPING CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS; contact: Robert Larrabee, A360 Technology Building, NBS, 301/921/3625.

June 7-9
SEVENTH INTERNATIONAL SYMPOSIUM ON ULTRASONIC IMAGING AND TISSUE CHARACTERIZATION, NBS, Gaithersburg, MD; sponsored by NBS, NIH, IEEE, and AIUM; contact: Melvin Linzer, A366 Materials Building, NBS, 301/921-2611.

***June 17**
21ST ANNUAL TECHNICAL SYMPOSIUM OF DC CHAPTER, ACM: COMPUTING AND GOVERNMENT, NBS, Gaithersburg, MD; sponsored by NBS and ACM; contact: Dennis Conti, A265 Technology Building, NBS, 301/921-3861.

October 4-8
NATIONAL CONFERENCE OF STANDARDS LABORATORIES, NBS, Gaithersburg, MD; sponsored by NBS and NCSL; contact: Brian Belanger, B362 Physics Building, NBS, 301/921-2805.

October 26-28
FOURTH IFAC/FIP SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS, the International Federation of Automatic Control, and the International Federation for Information Processing; contact: James Albus, A123 Metrology Building, NBS, 301/921-2381.

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PUBLICATIONS

NEW GUIDE FOR PACKAGED GOODS INSPECTION

Brickenkamp, C. S., Hasko, S., Natrella, M. G., Checking the Net Contents of Packaged Goods, Nat. Bur. Stand. (U.S.), Handb. 133, 164 pages (June 1981). Order by Stock No. 003-003-002331-1, from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; for $6 prepaid.

The National Bureau of Standards has issued a new handbook detailing recommended procedures for the weights and measures inspection of prepackaged commodities.

The new publication, Handbook 133, replaces NBS Handbook 67, *Checking Prepackaged Commodities,* and greatly extends the scope of the earlier work. The handbook is intended to be a procedural guide for inspectors from Federal, State, and local regulatory bodies.

Although NBS is an advisory agency with no regulatory powers, the procedures in the new handbook are expected to receive widespread use.

An important change introduced in Handbook 133 is the inclusion of two different sampling plans—methods that allow the package inspector to determine conformance with legal standards—depending on the size of the lot to be tested and the severity of the consequences of making an incorrect judgment.

Handbook 133 also includes detailed procedures for the measurement of a large variety of "special commodities" that pose tricky or difficult measurement problems, such as glazed seafood, mayonnaise, aerosols, very viscous materials, polyethylene sheeting, and peat moss.

Other useful sections in the handbook include a brief listing of Federal regulations governing package net contents declarations and a table of random numbers for use in selecting testing samples.

PRELIMINARY GUIDELINES ON SOLAR RETROFIT

Lerchen, F. H., Pielert, J. H., and Chen, P. T., Preliminary Guidelines for Condition Assessment of Buildings Being Considered for Solar Retrofit, Nat. Bur. Stand. (U.S.), NBSIR 81-2289, 139 pages (July 1981). Order by Stock No. PB81-217812 from National Technical Information Services, Springfield, VA 22161; for $9.50 prepaid.

A new report by the National Bureau of Standards can help engineers determine whether particular buildings are physically suitable for solar energy retrofitting. The report provides methods for evaluating candidate buildings in terms of the physical condition of their structural, mechanical, and electrical system.

The 139-page *Preliminary Guidelines for Condition Assessment of Buildings Being Considered for Solar Retrofit* (NBSIR 81-2289) was prepared under the Department of Energy's Solar Federal Buildings Program and was intended to assist Federal engineers and managers in appraising the impact of solar modifications of existing buildings. The report outlines technical procedures that are expected to have significant applications in the solar industry generally.

Among problems addressed by the NBS report are: structural effects of adding solar collectors and related equipment to the dead weight load of existing buildings; special adaptations and additional space requirements for accommodating solar equipment; and needed modifications in hot water systems, water supply and drainage systems, and electrical power and wiring systems.

Prepared by researchers at the Bureau's Center for Building Technology, the report discusses on-site and off-site investigation of building structures and systems, emphasizing techniques for preliminary on-site inspection. It cites the advantages and disadvantages of destructive and nondestructive evaluation methods as applied to structural materials of concrete, steel, masonry, and wood.

For each building material involved, comparative tables are provided to aid the reader in making a quick selection of an appropriate evaluation method. Checklists are also provided to identify common problems associated with each building material, possible causes of the problem, and its potential impact on existing building systems and the solar retrofit system.

The report notes that the ultimate decision on whether or not to adapt solar energy to a particular building cannot be made solely on the basis of the building's physical suitability. The availability of usable solar energy at the site, the costs of alternative energy sources, and life cycle costs of the existing building and its systems with respect to solar energy vis-a-vis other available forms of energy must also be considered.

Authors of the report anticipate that the preliminary publication will draw comment and recommendations from the technical community, providing the basis for a subsequent updated edition.

BUILDING TECHNOLOGY PROJECTS SUMMARIZED

Raufaste, N., and Olmert, M., Building Technology Project Summaries 1980-1981, Nat. Bur. Stand. (U.S.), Spec. Publ. 446-5, 82 pages (July 1981). Order by Stock No. 003-003-02343-4, from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; $4.50 prepaid.

More than 235 ongoing research projects carried out during 1980-1981 at the National Bureau of Standards Center for Building Technology are summarized in a new publication. Covering 11 prime research areas, the report lists the title and progress of the project, point of contract with CBT, and sponsor for each.

The areas are:

- Building economics
- Building rehabilitation technology
- Building and community acoustics
- Lighting technology
- Building service systems performance
- Structures and foundations performance
- Earthquake hazard reduction
- Building safety
- Energy conservation in buildings

- Building thermal envelope systems and insulating materials
- Building solar systems technology

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Webber, S., Ed., Building Technology Publications 1980—Supplement 5, Nat. Bur. Stand. (U.S.), Spec. Publ. 457-5, 90 pages (June 1981) Stock No. 003-003-02332-9, $4.50 prepaid.

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Kerns, D M., Plane-Wave Scattering-Matrix Theory of Antennas and Antenna-Antenna Interactions, Nat. Bur. Stand. (U.S.), Monogr. 162, 179 pages (June 1981) Stock No. 003-003-01955-0, $11 prepaid.

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Measurement Science and Technology: Policy and State-of-the-Art Surveys

Porter, G., National Bureau of Standards 1980, Nat. Bur. Stand. (U.S.), Spec. Publ. 600, 40 pages (Jan. 1981) Stock No. 003-003-02300-1, $2.50 prepaid.

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Albus, J. S., VanderBrug, G. J., Barbera, A. J., Fitzgerald, M. L., and Wheatley, T. E., Eds., NBS/RIA Robotics Research Workshop. Proceedings of a Workshop held at the National Bureau of Standards, November 13-15, 1979, Gaithersburg, Md., Nat. Bur. Stand. (U.S.), Spec. Publ. 602, 54 pages (Apr. 1981) Stock No. 003-003-02307-8, $3.75 prepaid.

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NEWS BRIEFS

IDENTIFICATION OF BACTERIA IN MONTANA GROUND WATERS. In a cooperative project with the Montana State University, NBS researchers have completed a study of microorganism populations in ground waters associated with the Madison Formation, a region of limestone rock underlying a large portion of the Northern Great Plains. In particular, researchers note the presence of sulfate-reducing bacteria believed to be responsible for the production of hydrogen sulfide (H_2S) in these waters. If the Madison Formation ground waters are used for industrial purposes in the future, the researchers say that biocorrosion of metal pipes, well casings, and holding tanks could present problems.

NBS AWARDS FOUR PRECISION MEASUREMENT GRANTS. Four university researchers have been awarded Precision Measurement Grants for experiments in high precision spectroscopy that are expected to refine our understanding of atomic physics and quantum electrodynamics and for an experiment to test the equivalence principle of relativity theory to new levels of accuracy. The grants were announced by NBS in cooperation with the National Science Foundation. The four $30,000 grants went to Professor David A. Church of Texas A & M University, Professor Michael G. Littman of Princeton University, Professor Charles E. Johnson of North Carolina State University, and Professor David F. Bartlett of the University of Colorado.

ANSI ADOPTS IGES FOR CAD/CAM DATA EXCHANGE. The Initial Graphics Exchange Specification (IGES), developed by an industry-government coalition managed by NBS to facilitate the exchange of graphics and design data between disparate CAD/CAM systems, has been adopted as a standard by the American National Standards Institute (ANSI). ANSI Subcommittee Y14.26 included IGES as three parts of the five-part standard Y14.26M, "Digital Representation for Communication of Product Definition Data," which was adopted on September 21. ANSI plans to advance Y14.26M for use as an international standard.

THOLEN NAMED SECRETARY OF NCWM. Albert Tholen, chief of the NBS Office of Weights and Measures, has been selected to be the new executive secretary of the National Conference on Weights and Measures. Tholen replaces Harold Wollin, who retired from NBS in October. The NCWM is an organization of Federal, State, and local officials and industry and business representatives that acts as an advisory body on technical and legal aspects of weights and measures regulation. The conference is chaired by the NBS director. The Bureau acts as the secretariat for the NCWM.

ELECTROMAGNETIC EMISSION STANDARDS. NBS is working with the Department of Transportation's Transportation Systems Center (TSC) to develop recommended practices for the emission of electromagnetic radiation from light-rail transit vehicles. At the same time, Bureau researchers are also helping to develop the necessary instruments and measurement techniques to support TSC's recommended practices which will affect manufacturers of motors, motor components, and signal and control equipment.

NEXT MONTH IN

DIMENSIONS/NBS

The field of quantum chemistry has developed into a more broadly applicable research tool that is used in such fields as combustion research, atmospheric chemistry, and laser technology. In the next issue of DIMENSIONS/NBS read how quantum chemists at NBS are using computers and mathematical models to describe the energy states, sizes, shapes, and spectra of molecules or chemical systems which are either difficult or impossible to observe directly.

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NATIONAL BUREAU OF STANDARDS
Ernest Ambler, Director

Prepared by the Public Information Division
Washington, DC 20234

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The Commerce Department's National Bureau of Standards was established by Congress in 1901 to advance the Nation's science and technology and to promote their application for public benefit. NBS research projects and technical services are carried out by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology. Manufacturing, commerce, science, government, and education are principal beneficiaries of NBS work in the fields of scientific research, test method developments, and standards writing. DIMENSIONS/NBS describes the work of NBS and related issues and activities in areas of national concern such as energy conservation, fire safety, computer applications, materials utilization, and consumer product safety and performance. The views expressed by authors do not necessarily reflect policy of the National Bureau of Standards or the Department of Commerce.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Annual subscription: Domestic, $11.00, foreign, $13.75. Single copy: Domestic, $2.25, foreign, $2.85. The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1982.